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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/809,317	03/24/2004	G. Ramanath	020752-000112US	6500

23308 7590 05/11/2006

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EXAMINER	
RODGERS, COLLEEN E	

ART UNIT	PAPER NUMBER
2813	

DATE MAILED: 05/11/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/809,317	RAMANATH ET AL.	
	Examiner	Art Unit	
	Colleen E. Rodgers	2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *13 March 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-11 and 24-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-11 and 24-28* is/are rejected.

7)☒ Claim(s) *1* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date ~~10/13/05~~ 1/3/05
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. This Office Action responds to the Amendment filed 13 March 2006. By this amendment, claims 1, 3, 8 and 24 are amended. Claims 1-11 and 24-28 remain pending.

Information Disclosure Statement

2. The objection to the Information Disclosure Statement in the Office Action dated 13 December 2005 is hereby withdrawn. The copy of the publication of **Yin et al** that was submitted by Applicant with the 11 September 2003 amendment in the parent case (serial number 09/976,927) was placed under an incorrect document code. The Examiner apologizes on behalf of the Office for any inconvenience. All references in the Information Disclosure Statement dated 3 January 2005 have been considered.

Claim Objections

3. Claim 1 is objected to because of the following informalities: at the end of the step labeled "c)", place a semicolon between "diffusion barrier" and "and" for proper punctuation. Appropriate correction is required.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1, 2 and 5-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Calvert et al** (USPN 5,389,496) in view of ***ASM Handbook*** *Vol. 5, Surface Engineering*, ASM International: Materials Park, OH, 1994, pp. 315-318, the basic textbook by **Porterfield**, *Inorganic Chemistry: A Unified Approach*, Addison-Wesley: Reading, MA, 1984, pp. 487-488, and the basic textbook by **Van Zant**, *Microchip Fabrication, Fifth Ed.*, McGraw-Hill: New York, 2004, pp. 419-426.

Regarding claim 1, **Calvert et al** discloses a method for forming a self-assembled monolayer comprising the steps of:

a) preparing a silicon substrate [see col. 5, line 52-col. 6, line 20 and col. 10, lines 49-56];

b) contacting the silicon substrate with a composition comprising self-assembled monolayer subunits and a solvent [see Example 1, col. 12];

c) removing the solvent [Example 33; see also col. 12, lines 52-56], thereby forming the diffusion barrier; and

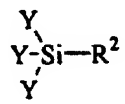
d) forming a metal layer on the diffusion barrier as formed in step (c) [see col. 3, lines 48-58].

Calvert et al does not disclose that the metal layer is formed using a vapor deposition process, or that said diffusion barrier inhibits copper diffusion into the substrate. **Van Zant** teaches that vapor deposition process such as sputtering may be used to deposit any material on any substrate [see p. 420]. It would have been obvious to one of ordinary skill in the art at the time of invention to use a vapor deposition method such as sputtering because **Van Zant** teaches that sputtering provides conservation of target material composition, uniform step coverage and uniform film formation [see p. 421].

Finally, the ***ASM Handbook*** teaches that copper may be used as a catalyst for electroless plating of copper (pp. 315-318, especially p. 318, sections entitled "Catalyzation" and "Copper catalyst"). **Porterfield** ensures that copper forms metal complexes with pyridine groups, such as the

pyridine group used in **Calvert et al** as the polar end-group of each molecule in the self-assembled monolayer barrier layer. It would have been obvious to one of ordinary skill in the art at the time of invention to use copper as the metal catalyst in **Calvert et al** as taught in the ***ASM Handbook*** because **Calvert et al** is not limited to Pd/Sn catalysts, and because copper is a known catalyst for electroless copper plating, as used in **Calvert et al**, as taught by the ***ASM Handbook***. In this regard, it has been held that the selection of a known material based upon its suitability for an intended purpose is obvious. Moreover, the ***ASM Handbook*** teaches that copper-based catalysts are less expensive than palladium-based catalysts, thereby providing additional motivation to use copper.

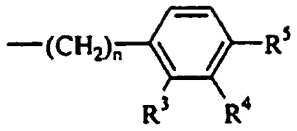
Regarding claim 2, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method of claim 1 as described above. Furthermore, **Calvert et al** discloses wherein the self-assembled monolayer unit is of the structure:



wherein Y is OCH_3 and wherein R^2 is a heteroalkyl group, specifically propylamine [see Example 4 (3-(trimethoxysilyl) propylamine)].

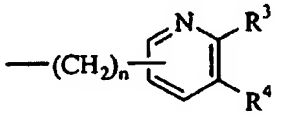
Regarding claim 5, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method of claim 1 as described above. Furthermore, **Calvert et al** discloses wherein the method further comprises the step of heating the silicon substrate and the composition during contact [see col. 12, lines 49-52].

Regarding claim 6, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method according to claim 2 as described above. Furthermore, **Calvert et al** discloses wherein R^2 is an alkyl group of the following structure:



wherein R^3, R^4 and R^5 are hydrogen, and wherein n is 1 [see Example 19 (4-chloromethylphenyltrimethoxysilane)].

Regarding claim 7, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method according to claim 2 as described above. Furthermore, **Calvert et al** discloses wherein R^2 is an alkyl group of the following structure:



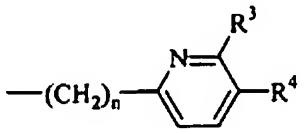
wherein R^3, R^4 and R^5 are hydrogen, and wherein n is 2 [see Examples 1, 2, 11, 19-24, 28, 29 and 31 (β-trimethoxysilylethyl-2-pyridine)].

Regarding claim 8, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method of claim 2 as described above. Furthermore, **Calvert et al** discloses wherein Y is OCH_3 [see Example 4 (3-(trimethoxysilyl) propylamine))].

Regarding claim 9, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method of claim 6 as described above. Furthermore, **Calvert et al** discloses wherein Y is OCH_3 [see Example 19 (4-chloromethylphenyltrimethoxysilane)].

Regarding claim 10, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method of claim 7 as described above. Furthermore, **Calvert et al** discloses wherein R^3, R^4 and R^5 are hydrogen, and wherein n is 2 [see Examples 1, 2, 11, 19-24, 28, 29 and 31 (β-trimethoxysilylethyl-2-pyridine)].

Regarding claim 11, the prior art of **Calvert et al**, ***ASM Handbook***, **Porterfield** and **Van Zant** disclose the method of claim 8 as described above. Furthermore, **Calvert et al** discloses wherein R^2 is an alkyl group of the following structure:



and wherein R^3 and R^4 are hydrogen and n is 2 [see Example 4 (3-(trimethoxysilyl) propylamine))].

6. Claims 1, 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Schnur et al** (USPN 5,079,600) in view of the basic textbook by **Van Zant**, *Microchip Fabrication, Fifth Ed.*, McGraw-Hill: New York, 2004, pp. 419-426.

Regarding claim 1, **Schnur et al** discloses a method for forming a diffusion barrier layer comprising the steps of:

a) preparing the silicon substrate [see col. 11, lines 24-26];

b) contacting the silicon substrate with a composition comprising self-assembled monolayer subunits and a solvent [see col. 11, lines 31-36];

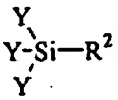
c) removing the solvent [see col. 11, lines 36-39], thereby forming the diffusion barrier; and

d) forming a metal layer on the diffusion barrier as formed in step (c) [see paragraph bridging columns 7 and 8], said diffusion barrier inhibiting copper diffusion into the substrate [see Example 24].

Schnur et al does not disclose that the metal layer is formed using a vapor deposition process. **Van Zant** teaches that vapor deposition process such as sputtering may be used to deposit any material on any substrate [see p. 420]. It would have been obvious to one of ordinary skill in the

art at the time of invention to use a vapor deposition method such as sputtering because **Van Zant** teaches that sputtering provides conservation of target material composition, uniform step coverage and uniform film formation [see p. 421].

Regarding claim 3, the prior art of **Schnur et al** and **Van Zant** disclose the method of claim 1 as described above. Furthermore, **Schnur et al** discloses wherein the self-assembled monolayer unit is of the following subunit:



wherein Y is chlorine, and wherein R^2 is a heteroaryl group, specifically pyridine [see Example 28 (trichloro(4-pyridyl)-ethylsilane)].

Regarding claim 4, the prior art of **Schnur et al** and **Van Zant** disclose the method of claim 1 as described above. Furthermore, **Schnur et al** discloses wherein the silicon substrate preparation comprises the formation of a silicon oxide surface [see col. 1, lines 24-26].

7. Claims 24-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Schnur et al** (USPN 5,079,600) in view of ***ASM Handbook*** *Vol. 5, Surface Engineering*, ASM International: Materials Park, OH, 1994, pp. 315-318, and the basic textbook by **Porterfield**, *Inorganic Chemistry: A Unified Approach*, Addison-Wesley: Reading, MA, 1984, pp. 487-488.

Regarding claim 24, **Schnur et al** discloses a method of forming a device, the method comprising:

(a) providing a substrate [see Fig. 1A];

(b) providing a diffusion barrier layer (called "thin film"), wherein the diffusion barrier comprises a self-assembled monolayer [see col. 10, lines 42-47], wherein the self-assembled

monolayer is a single layer of molecules [see col. 7, lines 11-15], and wherein the molecules in the self-assembled monolayer have first ends attached to the substrate and second ends projecting upward from the substrate [see Fig. 1A]; and

(c) forming a metal layer on the diffusion barrier layer as formed in step (b) using a vapor deposition process, wherein the metal layer is in direct contact with the second ends of the molecules in the self-assembled monolayer, and the diffusion barrier prevents diffusion of copper atoms into the substrate [see col. 9, lines 10-17, wherein a seed layer of Pd/Sn is coated over the self-assembled monolayer; see col. 4, lines 14-17, wherein vapor deposition is given as a known method for fabricating metal paths; and see Fig. 3A for the configuration thereof].

Schnur et al does not disclose that the metal layer is copper. The ***ASM Handbook*** teaches that copper may be used as a catalyst for electroless plating of copper (pp. 315-318, especially p. 318, sections entitled "Catalyzation" and "Copper catalyst"). **Porterfield** ensures that copper forms metal complexes with pyridine groups, such as the pyridine group used in **Schnur et al** as the polar end-group of each molecule in the self-assembled monolayer barrier layer. It would have been obvious to one of ordinary skill in the art at the time of invention to use copper as the metal catalyst in **Schnur et al** as taught in the ***ASM Handbook*** because **Schnur et al** is not limited to Pd/Sn catalysts, and because copper is a known catalyst for electroless copper plating, as used in **Schnur et al**, as taught by the ***ASM Handbook***. In this regard, it has been held that the selection of a known material based upon its suitability for an intended purpose is obvious. Moreover, the ***ASM Handbook*** teaches that copper-based catalysts are less expensive than palladium-based catalysts, thereby providing additional motivation to use copper. Finally, **Schnur et al** only requires that the catalyst bond to the polar end groups of the molecules (i.e., the pyridyl end groups of Example 28 in

Schnur et al). **Porterfield** ensures that such bonding occurs, such that one of ordinary skill has a reasonably expectation of success for using copper instead of Pd/Sn as the catalyst in **Schnur et al**.

Regarding claim 25, it is held absent evidence to the contrary that the diffusion barrier of **Schnur et al** is capable of preventing diffusion of metal atoms from the metal layer into the substrate when the semiconductor device is exposed to an electric field of 2 MV/cm at about 200° for about 30 minutes. Basis for this reasoning is that Applicant is using the exact same self-assembling monolayer as is **Schnur et al** to form the barrier layer. **Schnur et al** also points out in Example 24 that copper diffusion does not occur even under the stress of an electric field. See *In re Swinehart*, 169 USPQ 226, 229 (CCPA 1971) (where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on) and *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103). Note that as long as there is evidence of record establishing inherency, failure of those skilled in the art to contemporaneously recognize an inherent property, function or ingredient of a prior art reference does not preclude a finding of anticipation. See *Atlas Powder Co. v. IRECO, Inc.*, 190 F.3d 1342, 1349, 51 USPQ2d 1943, 1948 (Fed. Cir. 1999) (Two prior art references disclosed blasting compositions containing water-in-oil emulsions with identical ingredients to those claimed, in overlapping ranges with the claimed composition. The only element of the claims arguably not present in the prior art compositions was "sufficient aeration ... entrapped to enhance sensitivity to a substantial degree." The Federal Circuit found that the

emulsions described in both references would inevitably and inherently have "sufficient aeration" to sensitize the compound in the claimed ranges based on the evidence of record (including test data and expert testimony). This finding of inherency was not defeated by the fact that one of the references taught away from air entrapment or purposeful aeration.). See also *In re King*, 801 F.2d 1324, 1327, 231 USPQ 136, 139 (Fed. Cir. 1986); *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782, 227 USPQ 773, 778 (Fed. Cir. 1985).

Regarding claim 26, Example 24 in **Schnur et al** states that the substrate is a silicon wafer with silicon oxide formed thereon.

Regarding claim 27, the first ends of the molecules in **Schnur et al** is a pyridyl group, which is an aromatic group.

Regarding claim 28, **Schnur et al** teaches that sputtering is a known form of vapor deposition for fabricating metal paths [see col. 4, lines 14-17].

Response to Arguments

8. Applicant's arguments with respect to claims 1-11 and 24-28 have been considered but are moot in part in view of the new ground(s) of rejection. The remaining arguments are addressed below.

9. Applicant's arguments filed 13 March 2006 have been fully considered but they are not persuasive. First, Applicant alleges that **Calvert et al** does not disclose that the self-assembled monolayer described is a diffusion barrier. Examiner admits that this is so, insofar as the words "diffusion" and "barrier" are not explicitly stated; however, by virtue of the fact that **Calvert et al** discloses exactly the same self-assembled monolayer as the instant application, Examiner submits that the self-assembled monolayer of **Calvert et al** is capable of functioning as such.

Secondly, Applicant alleges that the electroplated metal layer of both **Calvert et al** and **Schnur et al** is substantially different than the instantly claimed metal layer formed by vapor deposition. Examiner disagrees. Applicant's invention is drawn to a diffusion barrier layer, not a metal layer. Absent a showing that a metal layer formed by sputtering **diffuses** differently than a metal layer formed by electroplating, it is held that electroplating is an obvious alternative method to the vapor deposition method instantly claimed.

Thirdly, Applicant alleges that the process of **Schnur et al** involves modification of the as-formed SAM. Examiner agrees that the method of **Schnur et al**, in an exemplary capacity, discusses modification of the self-assembled monolayer, but that said modification is not required. Examiner again submits that since vapor deposition is a known alternative process to electroplating, the modification of the SAM layer to make it more compatible for an electroplating process does not cause the instantly claimed process to be patentably distinguished over the cited prior art. The method by which the metal layer is deposited has not been indicated to be critical to the instant invention, namely, a self-assembled monolayer, and is not considered novel. (See instant specification, p. 2, section entitled "Summary of the Invention.") The prior art of **Schnur et al** discloses the exact same barrier layer as is presently claimed.

Fourthly, Applicant alleges that the devices produced by the methods of **Schnur et al** and the devices produced by the recited method are not inherently equivalent. Examiner vigorously disagrees. As explained in great detail above, the method of forming the metal layer is non-novel, and one of ordinary skill would reasonably expect the self-assembled monolayer of the cited prior art to function identically to the self-assembled monolayer instantly claimed regardless of the deposition method employed, absent a showing to the contrary.

Finally, Applicant alleges that the test performed in Example 24 of **Schnur et al** does not indicate any practical barrier property. Examiner contends that it does; and furthermore that even if it doesn't this point does not patentably distinguish the claims over the prior art. The disclosure of the **exact same** monolayer in the cited prior art is enough to anticipate and/or render obvious the claimed subject matter, whether or not the inventors of the prior art invention recognized the diffusion barrier qualities of the self-assembled monolayer disclosed. The test performed in Example 24 of **Schnur et al** is merely evidence that the diffusion barrier properties were recognized. See *In re Swinehart*, 169 USPQ 226, 229 (CCPA 1971) (where the Patent Office has reason to believe that a functional limitation asserted to be critical for establishing novelty in the claimed subject matter may, in fact, be an inherent characteristic of the prior art, it possesses the authority to require the applicant to prove that subject matter shown to be in the prior art does not possess the characteristics relied on) and *In re Fitzgerald*, 205 USPQ 594 (CCPA 1980) (the burden of proof can be shifted to the applicant to show that subject matter of the prior art does not possess the characteristic relied on whether the rejection is based on inherency under 35 USC 102 or obviousness under 35 USC 103). Note that as long as there is evidence of record establishing inherency, failure of those skilled in the art to contemporaneously recognize an inherent property, function or ingredient of a prior art reference does not preclude a finding of anticipation. See *Atlas Powder Co. v. IRECO, Inc.*, 190 F.3d 1342, 1349, 51 USPQ2d 1943, 1948 (Fed. Cir. 1999) (Two prior art references disclosed blasting compositions containing water-in-oil emulsions with identical ingredients to those claimed, in overlapping ranges with the claimed composition. The only element of the claims arguably not present in the prior art compositions was "sufficient aeration ... entrapped to enhance sensitivity to a substantial degree." The Federal Circuit found that the emulsions described in both references would inevitably and inherently have "sufficient aeration" to

sensitize the compound in the claimed ranges based on the evidence of record (including test data and expert testimony). This finding of inherency was not defeated by the fact that one of the references taught away from air entrapment or purposeful aeration.). See also *In re King*, 801 F.2d 1324, 1327, 231 USPQ 136, 139 (Fed. Cir. 1986); *Titanium Metals Corp. v. Banner*, 778 F.2d 775, 782, 227 USPQ 773, 778 (Fed. Cir. 1985).

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Colleen E. Rodgers whose telephone number is (571) 272-8603. The examiner can normally be reached on Monday through Friday, 9:00 AM to 6:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CER

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